

Data Communication and Net-Centric Computing

COSC 1111/2061/1110

Lecture 9

Wireless Networking

Lecture Overview

❖ During this lecture, we will learn

- 802.11 Wireless LAN
- Bluetooth
- Cellular Communications
- Satellite Networks

❖ Recommended reading

- Chapters 14 and 17 (Stallings)

- ❖ **Wireless communications compelling**
 - ✓ Easy, low-cost deployment
 - ✓ **Mobility & roaming: Access information anywhere**
 - ✓ Supports personal devices
 - ✓ PDAs, laptops, data-cell-phones
 - ✓ Supports communicating devices
 - ✓ Cameras, location devices, wireless identification
 - ✗ Signal strength varies in space & time
 - ✗ Signal can be captured by snoopers
 - ✗ **Spectrum is limited & usually regulated**

Wireless LAN Applications

❖ Cross-Building Interconnect

- Connect nearby buildings

❖ Nomadic Access

- Wireless link between a LAN hub and mobile data terminal with antenna

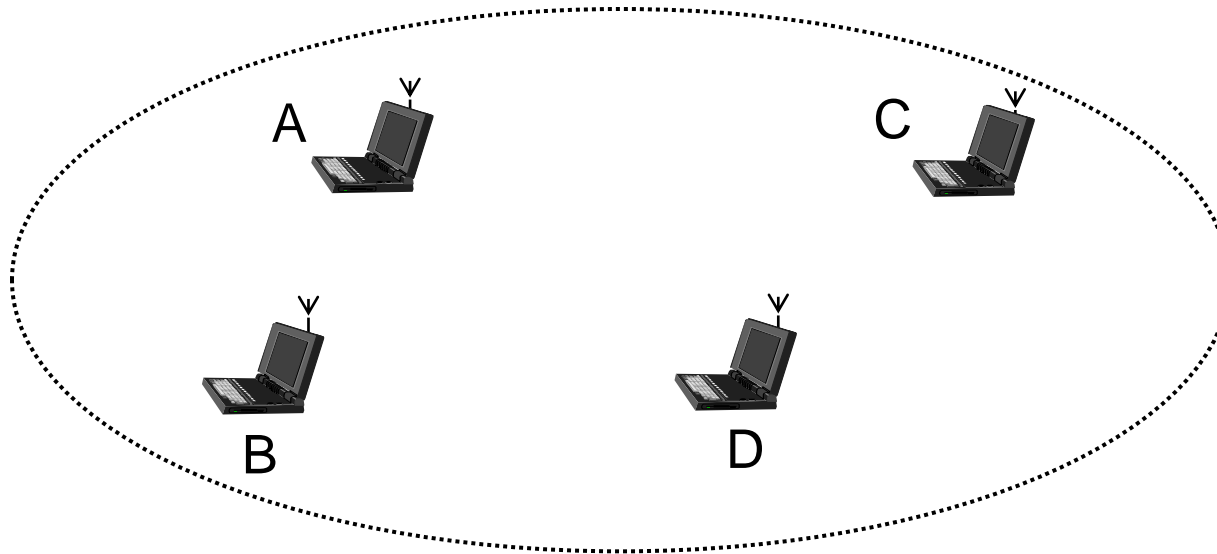
❖ WiFi (Wireless Fidelity) HotSpots

- Cafes, restaurants, coffee shops, libraries, airports, downtown business districts, malls, retail stores, etc. that are open to the public

❖ Ad Hoc Networking

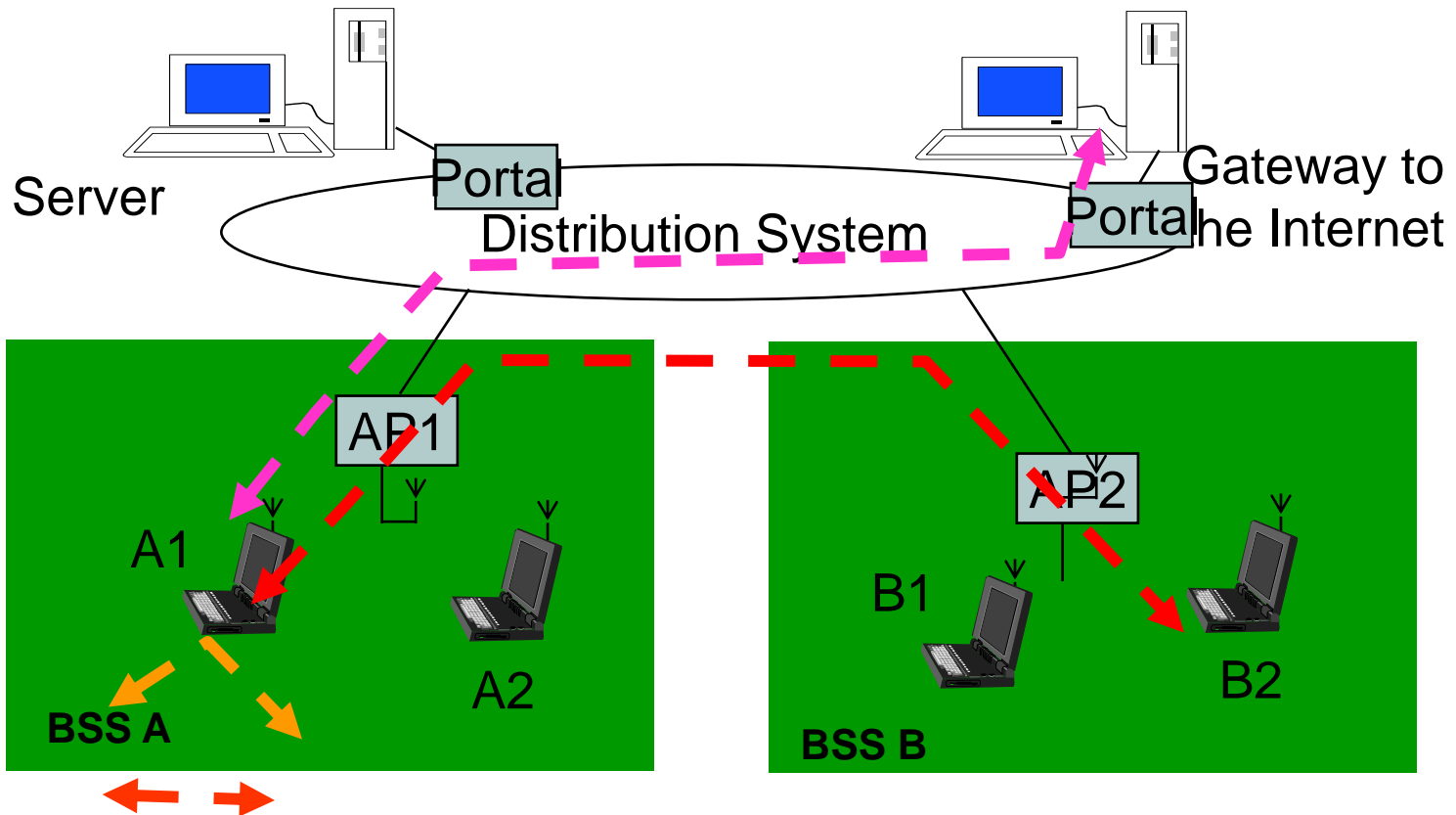
- Peer-to-peer network

Ad Hoc Communications



- ❖ **Temporary association of group of stations**
 - Within range of each other
 - Need to exchange information
 - E.g. Presentation in meeting, or distributed computer game, or both

Infrastructure Network



❖ **Permanent Access Points provide access to Internet**

802.11 Definitions

❖ *Basic Service Set (BSS)*

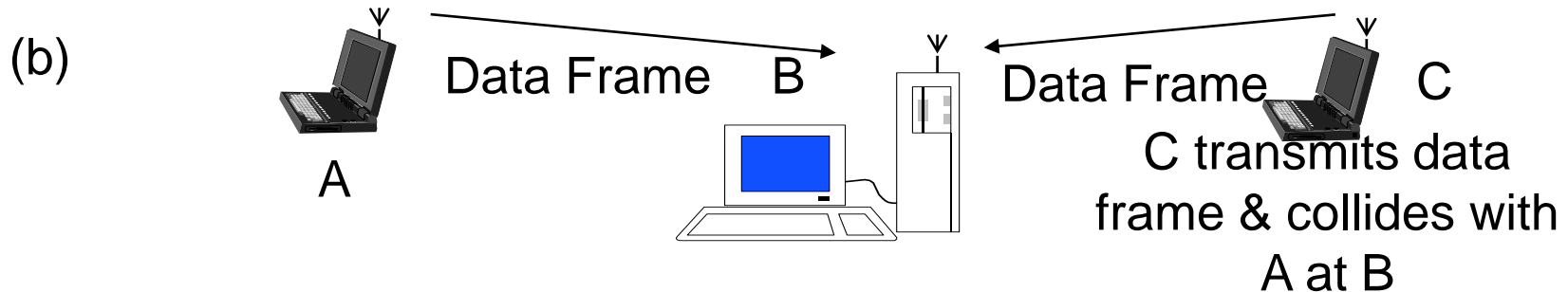
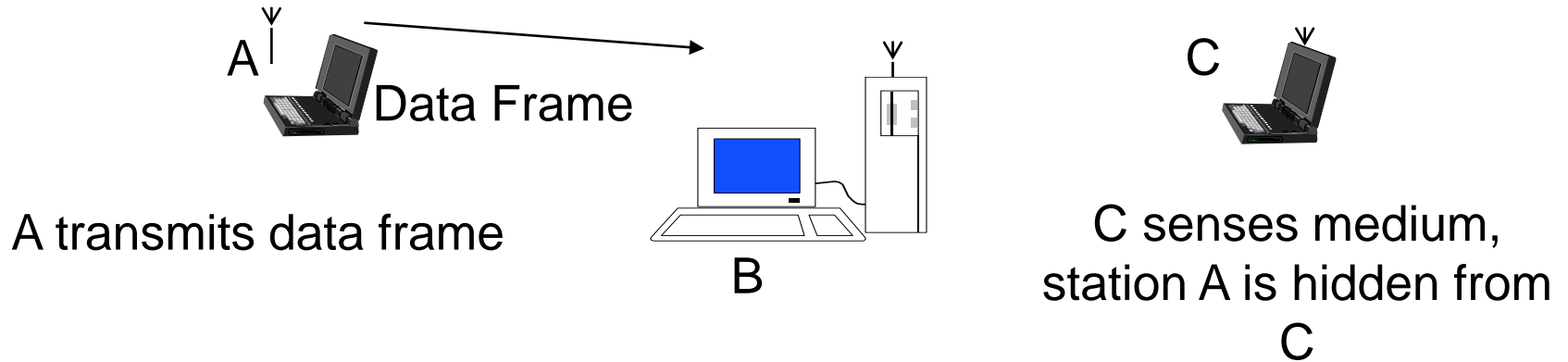
- Group of stations that *coordinate their access* using a given instance of MAC
- Located in a *Basic Service Area (BSA)*
- Stations in BSS can communicate with each other
- Distinct collocated BSS's can coexist

❖ Stations within BSS can communicate directly with each other

❖ *Extended Service Set (ESS)*

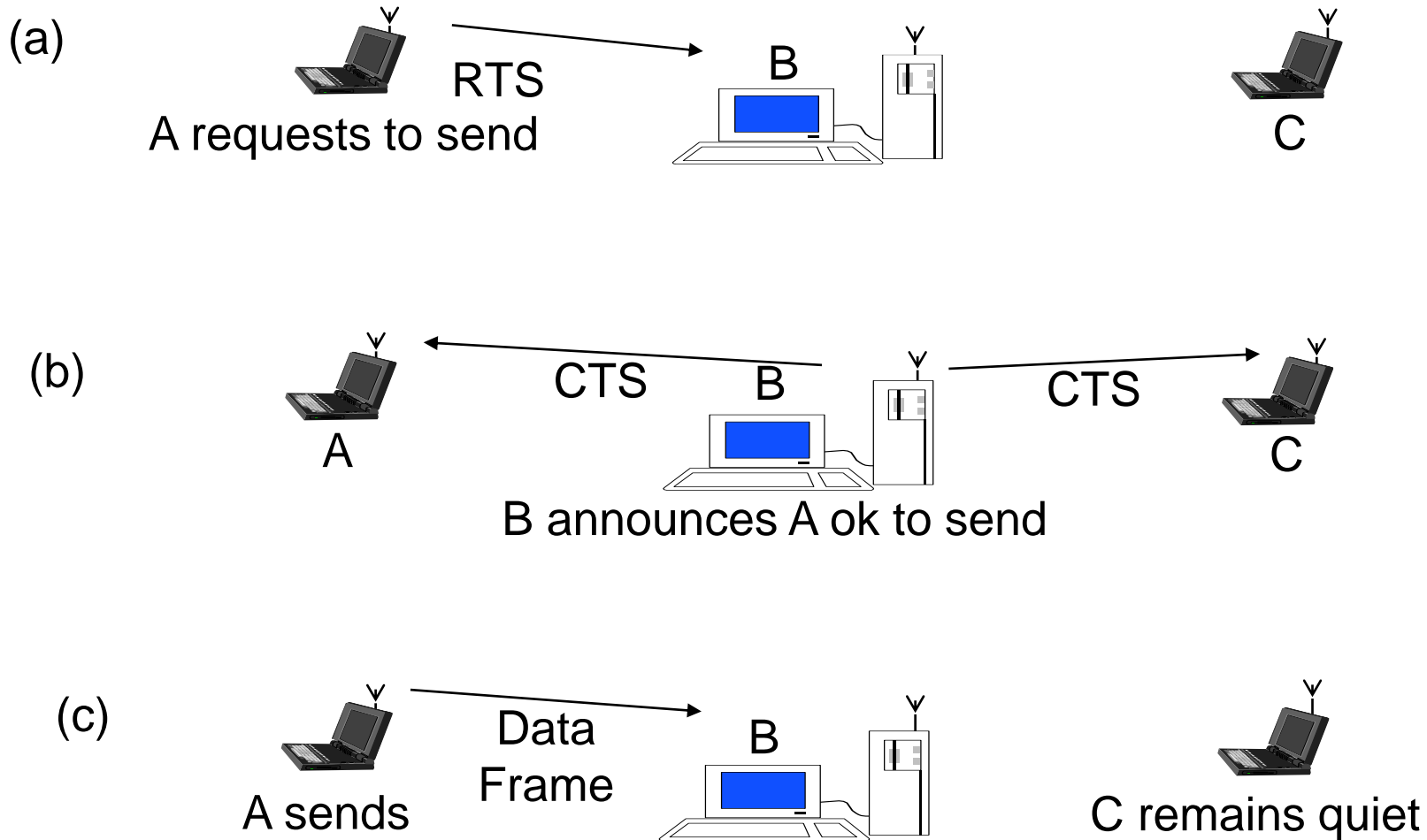
- Multiple BSSs interconnected by *Distribution System (DS)*
- Each BSS is like a cell and stations in BSS communicate with an *Access Point (AP)*
- *Portals* attached to DS provide access to Internet

Hidden Terminal Problem



❖ New MAC: CSMA with *Collision Avoidance*

CSMA with Collision Avoidance



What is Bluetooth?

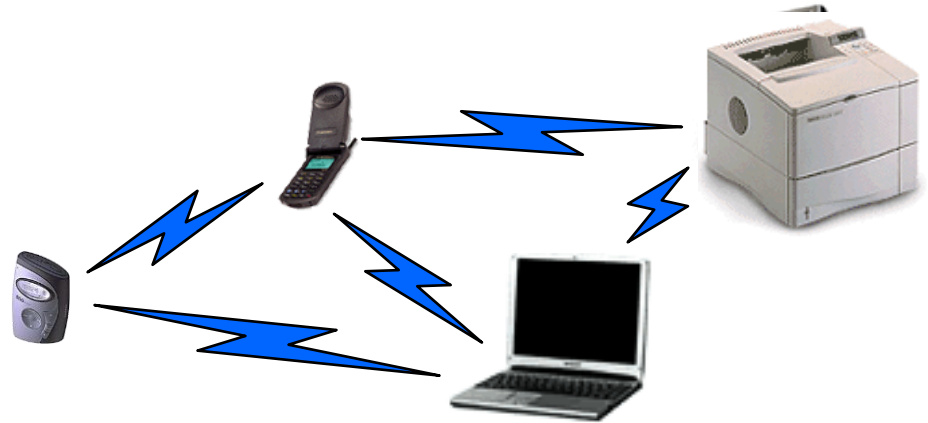
A unique new wireless technology specifically for:

- ❖ Short range
 - Up to 10 meters typically
- ❖ Modest performance (721Kbps)
- ❖ Dynamic configurability
 - i.e. ad hoc networking/roaming
- ❖ Low power
 - Well suited to handheld applications
- ❖ Support for both voice and data
- ❖ Modulation- uses a sophisticated version of FSK to transform bits to signal
- ❖ Multiplexing – a form of TDMA

What is Bluetooth Good For?

❖ No Wires!

- In the home
- On the move



❖ Personal Area Networking (PAN)

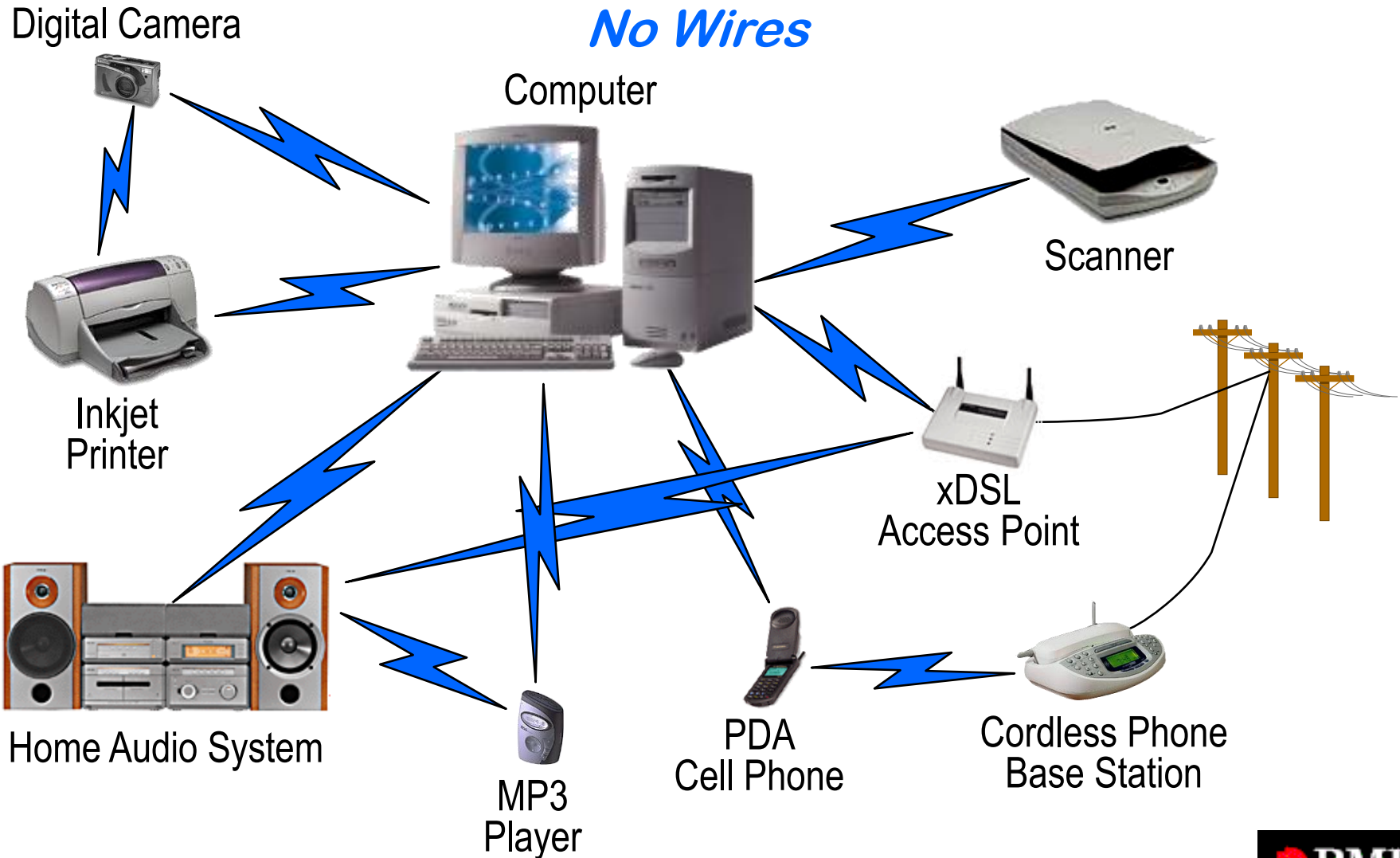
- Enabling a collection of YOUR personal devices to cooperatively work together

❖ Locality sensitive services (i.e. roaming)

- Visibility and access to additional resources, but only when they are within range and useful to you

Bluetooth in the Home

No Wires



Bluetooth in Computer Products

Computer devices

- ❖ Laptop computers
- ❖ PDAs/HPCs
- ❖ Desktop PCs
- ❖ Broadband access points
 - Ethernet/xDSL/cable
- ❖ Printers
- ❖ Scanners
- ❖ Video projectors
- ❖ Web tablets

Computer applications

- ❖ Peripheral connectivity
 - Printers
 - Scanners
 - Video projectors
- ❖ Network access
 - Broadband access points
 - Packet radio cellular phones
- ❖ File synchronization
 - Calendars
 - Contact management
- ❖ File transfer
 - VCards
 - MP3
 - Digital pictures

Bluetooth in Telephone and Consumer Products

Telephone devices

- ❖ Cellular handsets
- ❖ Wireless headsets
- ❖ PSTN access points
 - Payphones
 - Hotel/home phones

Consumer devices

- ❖ Set-top boxes
- ❖ Digital cameras
- ❖ MP3 audio players
- ❖ Home audio systems

Telephone applications

- ❖ Hands free use
- ❖ File synchronization
 - Calendars
 - Contact management
- ❖ Land line I/F for voice and data

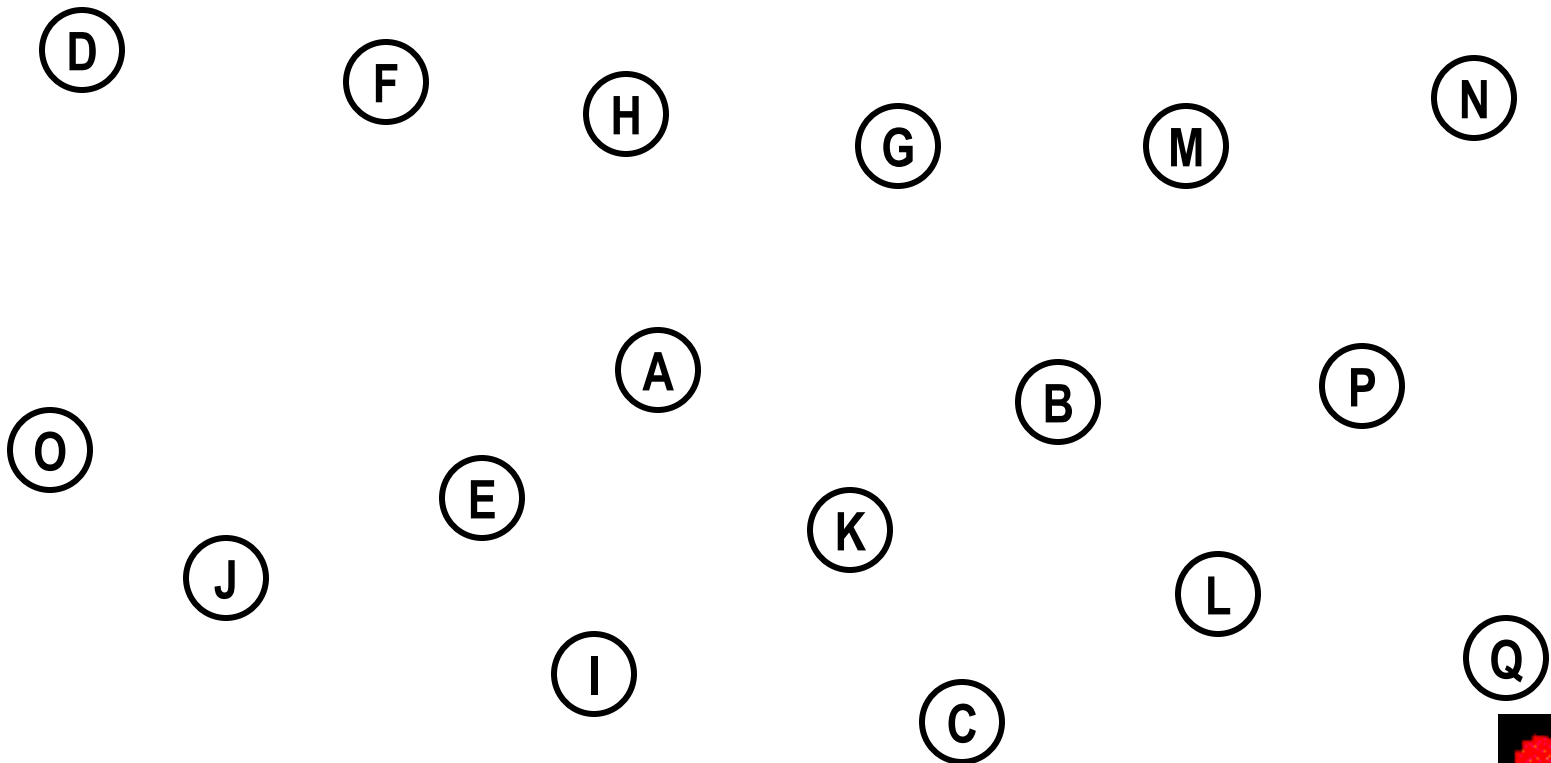
Consumer applications

- ❖ File transfer
 - MP3
 - Digital pictures
- ❖ Peripheral connectivity
 - Keyboard/mouse/remote
 - Printer

Bluetooth Devices in Standby Mode

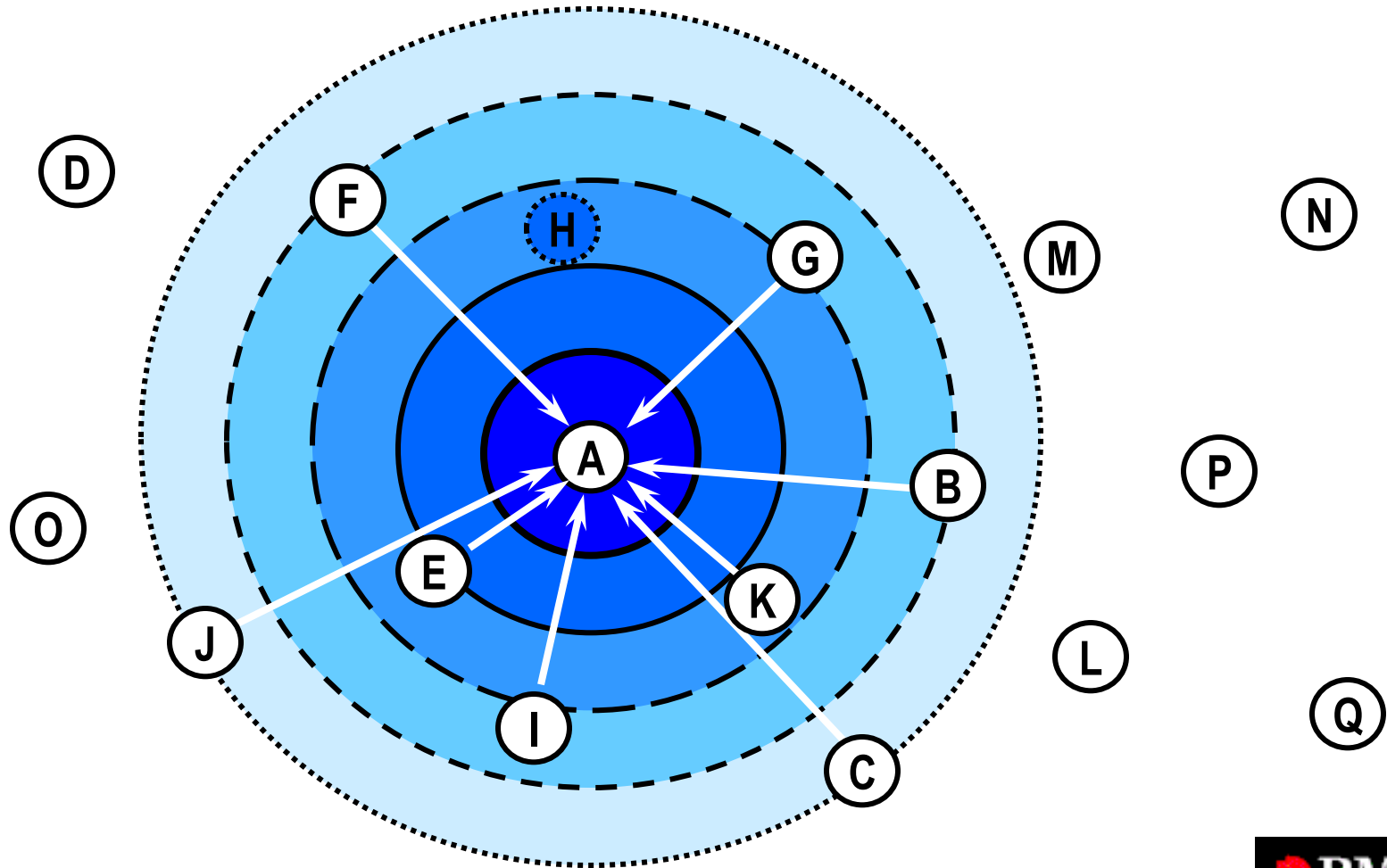
❖ Initially Bluetooth devices only know about themselves

- Everyone passively monitors in Standby mode
- No devices are synchronized



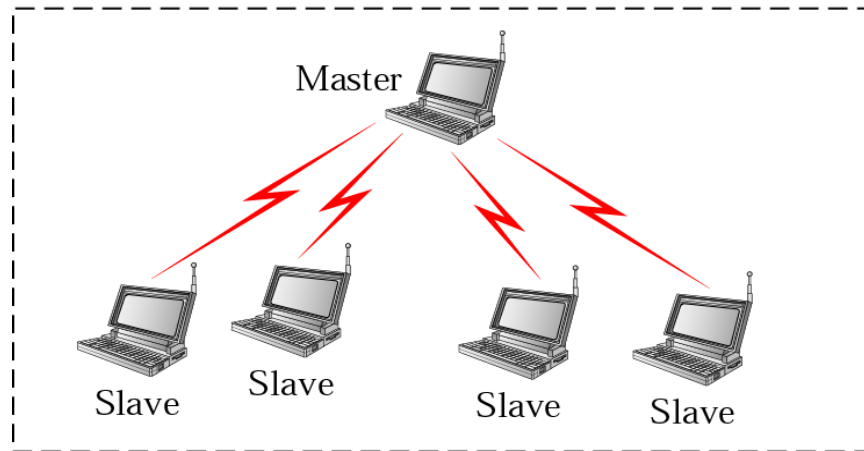
Bluetooth – Device Discovery

❖ Inquiry discovers what other devices within range



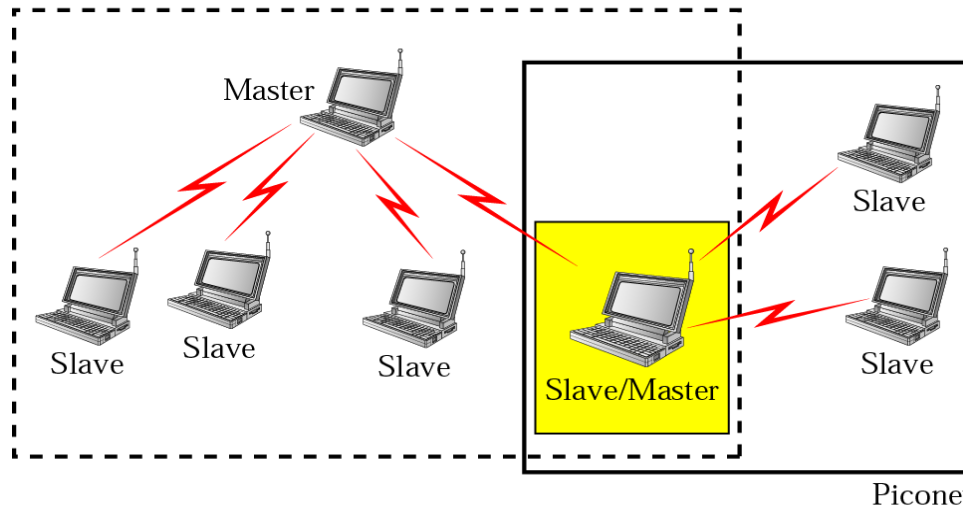
Bluetooth – Piconet and Scatternet

Piconet



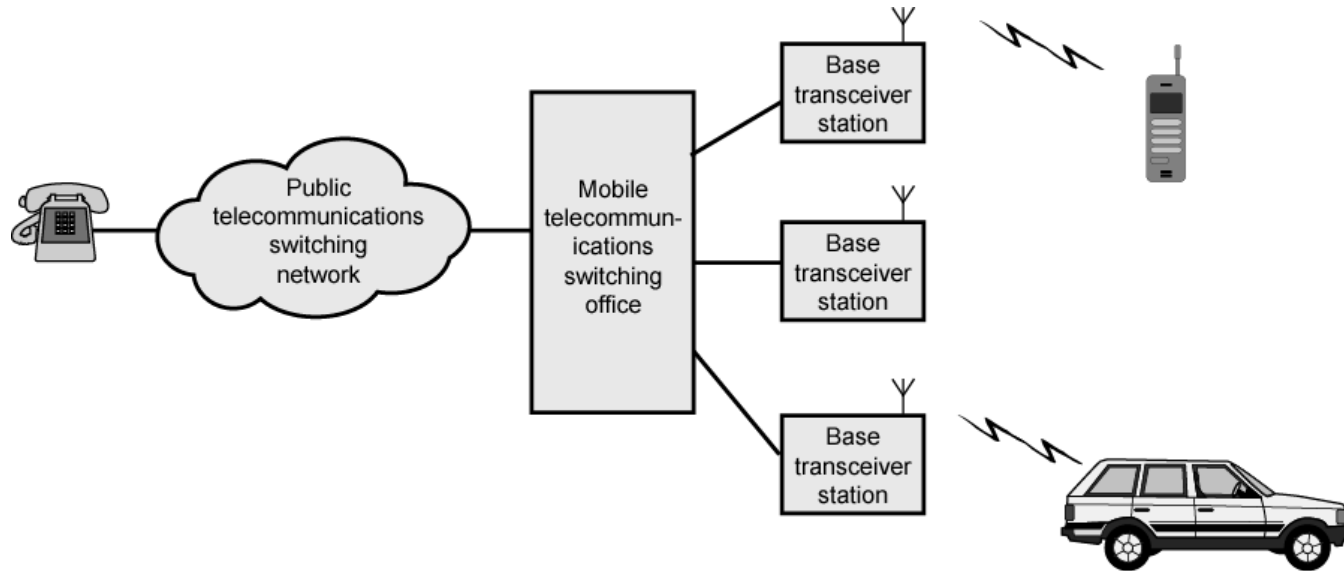
- ❖ A bluetooth network is called a piconet.
- ❖ Total 8 stations – 1 master, 7 slaves.

Piconet



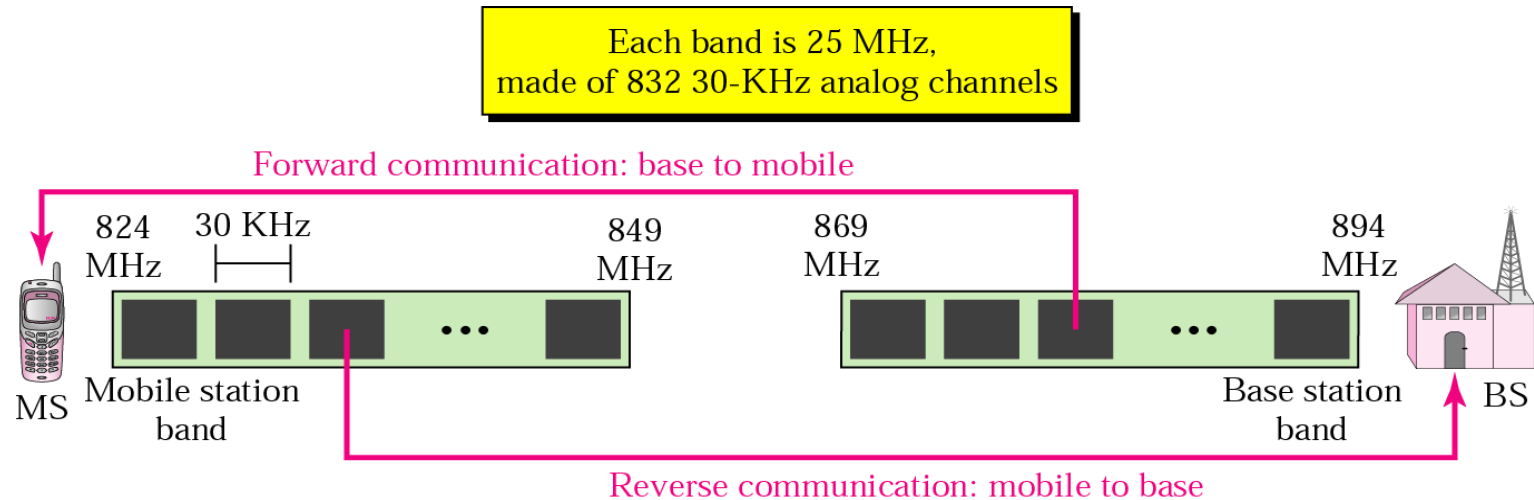
- ❖ Combining piconets form scatternet.
- ❖ A slave station in one piconet can become the master in another piconet

Overview of Cellular System



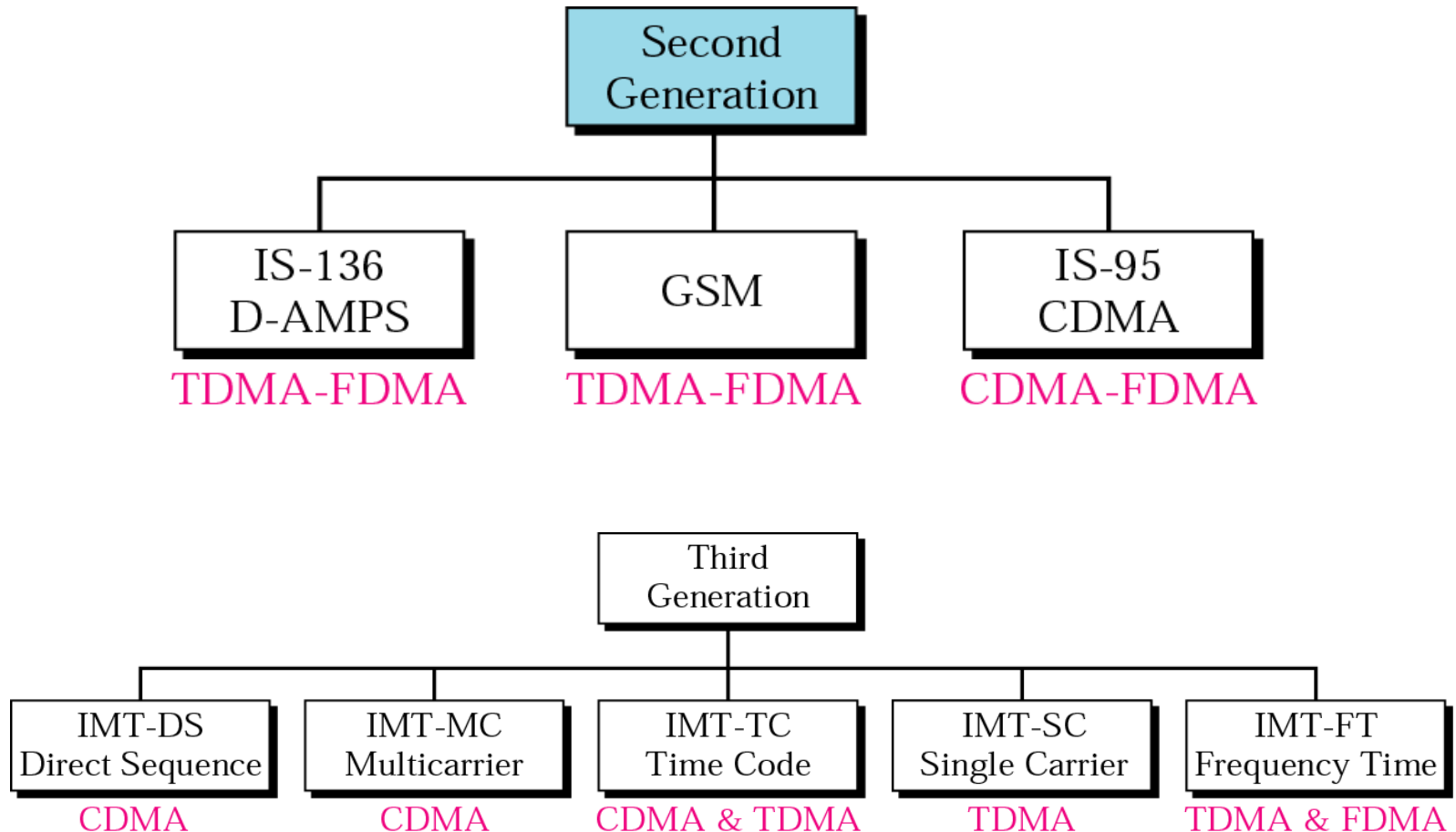
- ❖ Underlying technology for mobile phones, personal communication Area divided into cells
 - Each with own antenna
 - Each with own range of frequencies
 - Served by base station
 - Transmitter, receiver, control unit
 - Adjacent cells on different frequencies to avoid crosstalk

Advanced Mobile Phone Systems (AMPS)

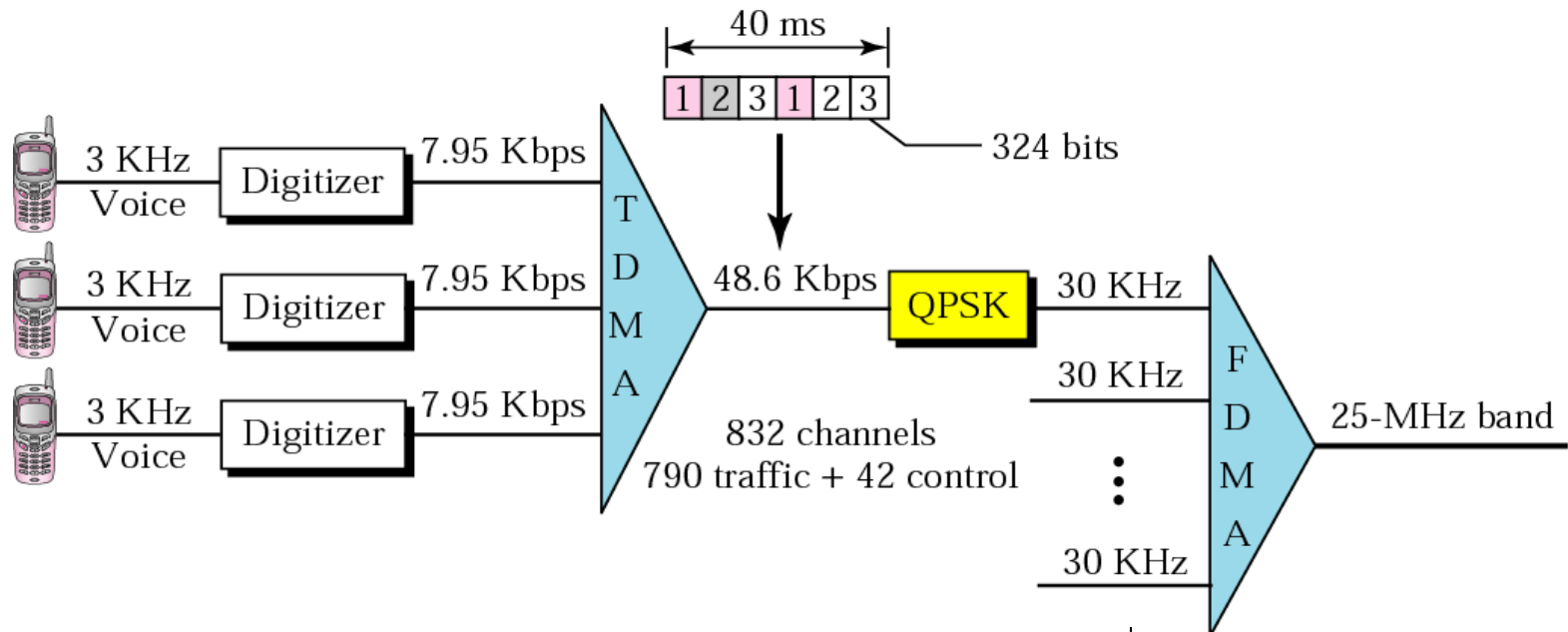


- ❖ Original cellular telephone networks
- ❖ Analog traffic channels
- ❖ Early 1980s in North America
- ❖ Two separate analog channels – forward (base to mobile) and reverse (mobile to base)
- ❖ AMPS is an analog cellular phone system using FDMA.

2nd/3rd -generation cellular phone systems



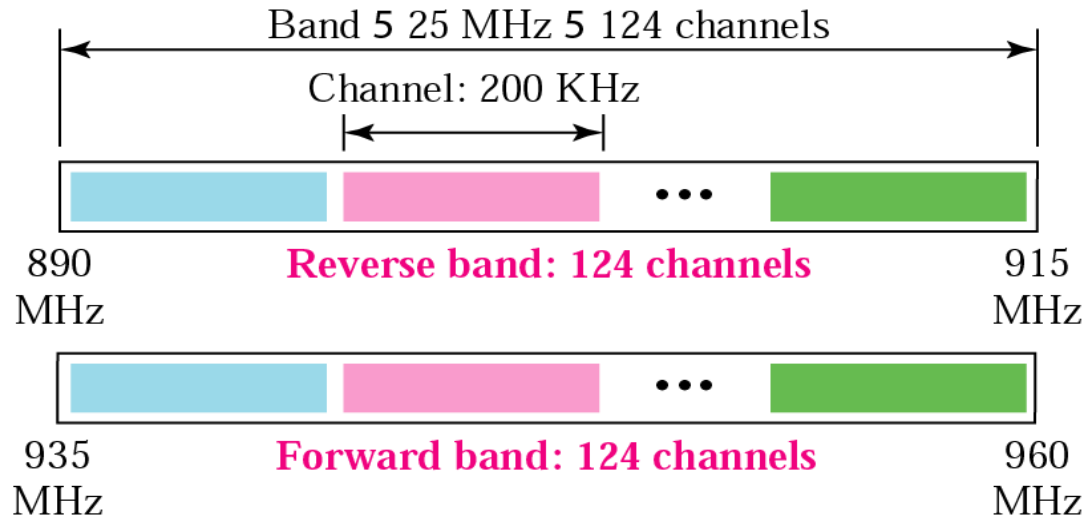
D-AMPS



- ❖ **D-AMPS uses the same bands and channels as AMPS**
- ❖ **Backward compatible with AMPS.**
- ❖ **A voice channel is digitized to 7.95 kbps.**
- ❖ **Three 7.95 kbps channels combined using TDMA**
- ❖ **48.6 kbps of digital data modulates using QPSK**

- Each slot holds 324 bits- 159 dig voice+ 64 bits control+ 101 bits error correction
- 25 frames/sec. Each frame lasts $1/25s=40$ ms.
- Each frame has 1944 bits. Divided into 6 slots shared by 3 channels.
- Each channel gets 2 slots

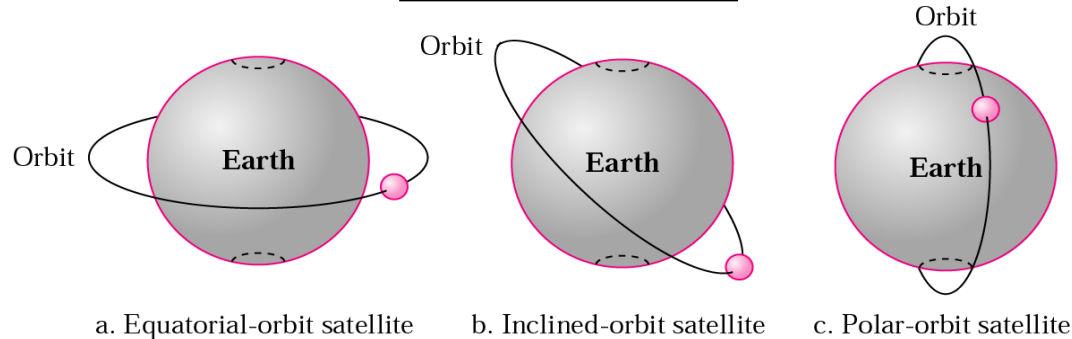
GSM bands



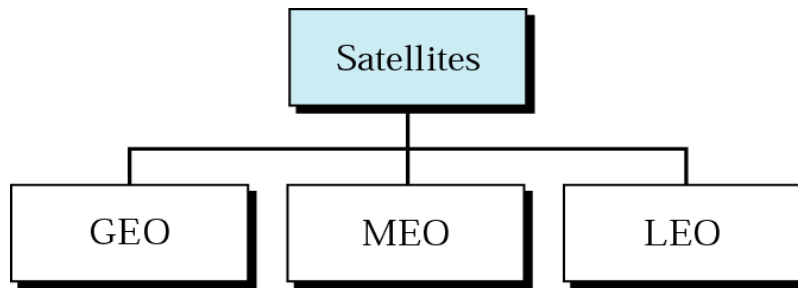
- ❖ **GSM- Global System for Mobile Communication.**
- ❖ **European Standard to replace incompatible 1st generation technologies**
- ❖ **GSM uses two bands**
- ❖ **Each band 25 Mhz, divided into 124 channels of 200 Khz**
- ❖ **GSM is a digital cellular phone system using TDMA and FDMA**

Satellite Basics

Satellite orbits



Satellite categories

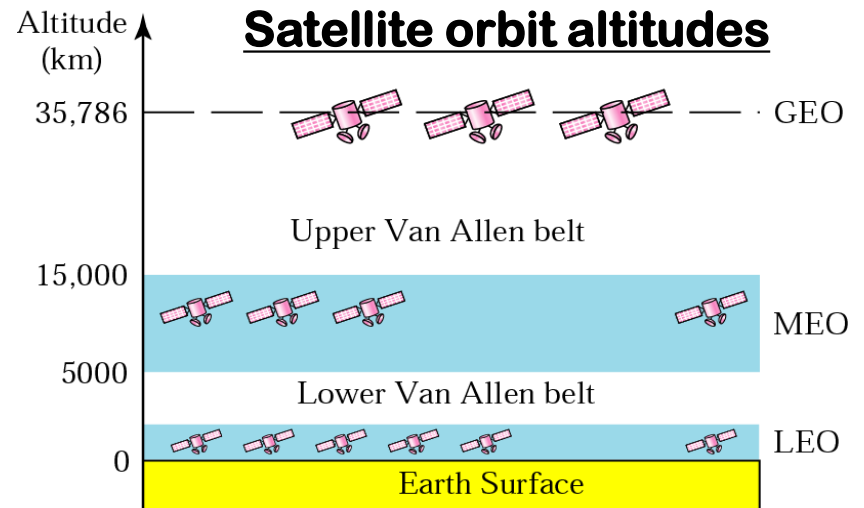


LEO – Low-Earth Orbit

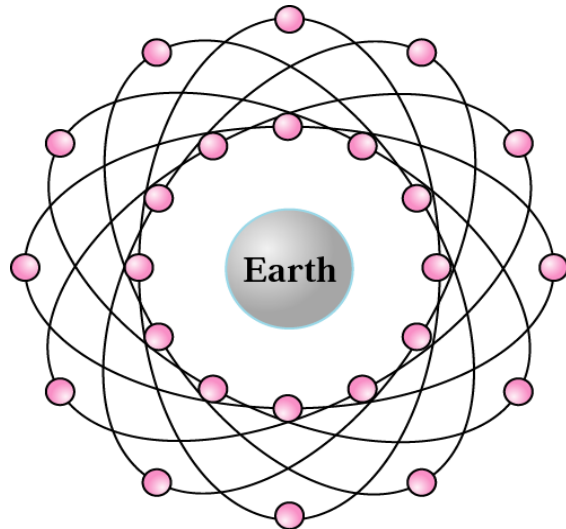
MEO – Medium-Earth Orbit

GEO – Geosynchronous-Earth Orbit

Satellite orbit altitudes

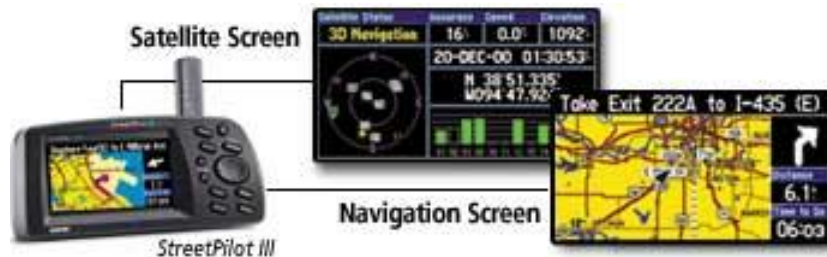


Global Positioning System (GPS)



❖ Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit

❖ Satellites orbiting the earth about 12,000 miles above us (MEO)



❖ The GPS receiver compares the time a signal was transmitted by a satellite with the time it was received.

❖ The time difference tells the GPS receiver how far away the satellite is.

❖ With distance measurements from a few more satellites, the receiver can determine the user's position and display it on the unit's electronic map.

SOURCE: <http://www.garmin.com/aboutGPS/>

Applications of GPS



Mapping System



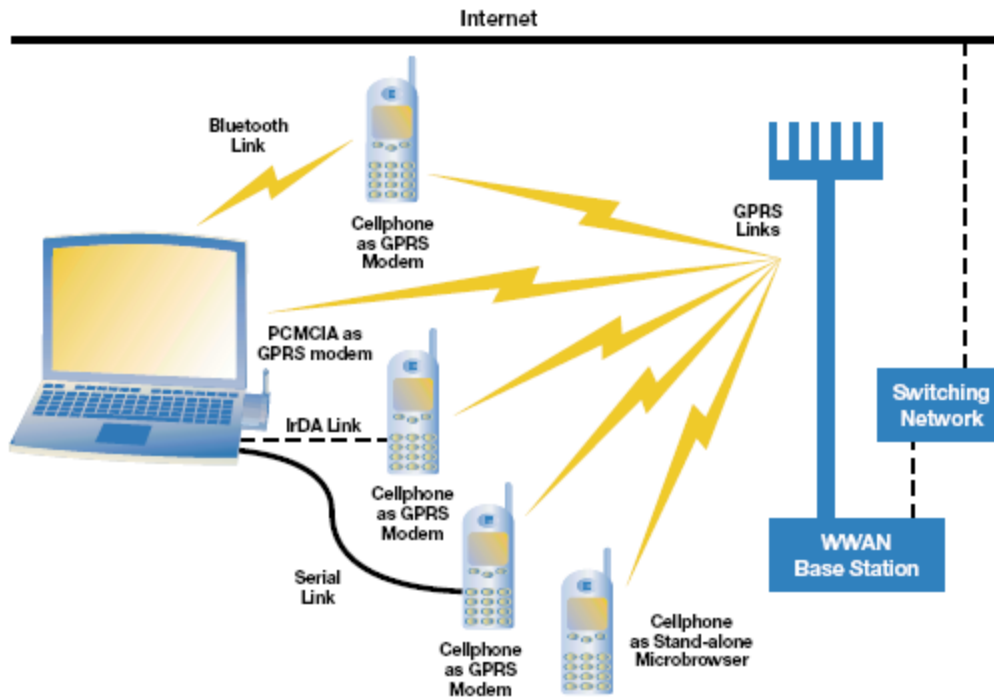
GPS System for the Blind



Personal Navigation System

SOURCE: <http://www.gpsworld.com>

General Packet Radio Service (GPRS)



- ❖ GPRS allows a continuous wireless connection to data networks
- ❖ GPRS is a step between GSM and 3G cellular networks.
- ❖ offers data transmission via a GSM network within a range 9.6Kbits to 115Kbits

- ❖ GPRS technology allows mobile phones to be used for sending and receiving data over an IP based network.
- ❖ The applications using GPRS are WAP, MMS, SMS, Java and the PC dial-up (for example, Internet and e-mail)

SOURCE: <http://www.intel.com/update/departments/wireless/wi10021.pdf>

WiMax (802.16)

- ❖ WiMAX is a term meaning Worldwide Interoperability for Microwave Access (WiMAX).
- ❖ WiMAX is at its heart is a standards initiative. The purpose is to ensure that the broadband wireless radios manufactured for customer use interoperate from vendor to vendor.
- ❖ The primary advantages of the WiMAX standard are to enable the adoption of advanced radio features in a uniform fashion and reduce costs

Uses for WiMAX

The bandwidth and reach of WiMAX make it suitable for the following potential applications:

- ❖ Connecting Wi-Fi hotspots with each other and to other parts of the Internet
- ❖ Providing a wireless alternative to cable and DSL for last mile (last km) broadband access.
- ❖ Providing high-speed mobile data and telecommunications services (4G)

Source: <http://www.wimax.com>

<http://en.wikipedia.org/wiki/WiMAX>

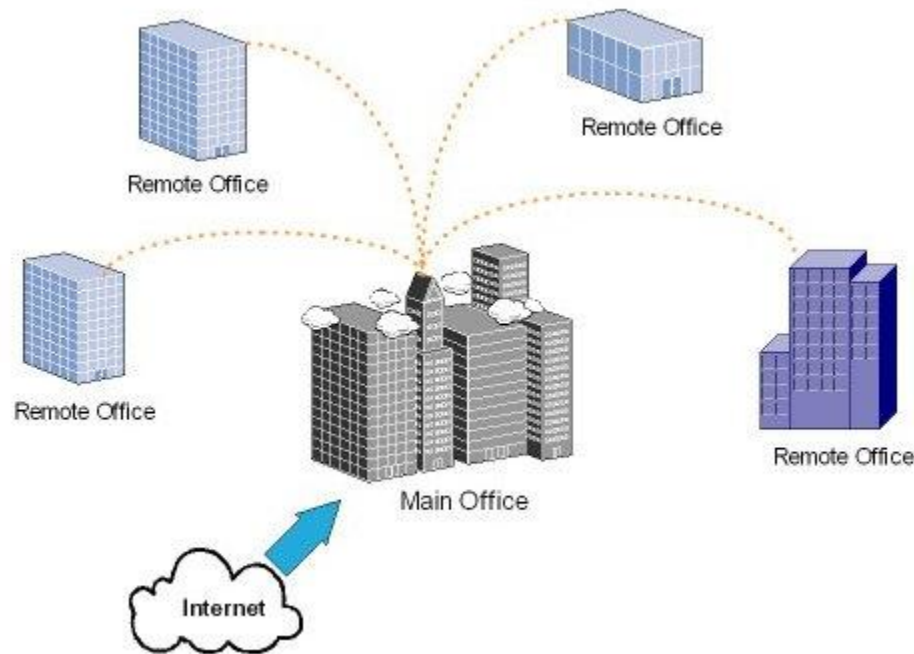
WiMax Deployment Scenario



- ❖ Campus & Wireless ISP (Point to Multi-Point)
- ❖ from a central location to a number of buildings or other locations with ranges up to 15 miles (24 Kms) and data speeds up to 72 Mbps
- ❖ equipment usually consists of a centralized base stations and a number of end-user CPEs (customer premise equipment)

Source:<http://www.wimax.com>

WiMax Deployment Scenario



❖ Wireless broadband Metropolitan Area Networks (MANs) connect buildings and remote locations up to 40 miles (65Kms) at data rates from 2Mbps to 1 Gbps (depending on frequency, distance)

Source: <http://www.wimax.com>

Summary

- ❖ In this lecture, we have understood:
 - Wireless LAN, Bluetooth
 - CSMA/CA
 - Cellular and Satellite Communications
 - 1st, 2nd generation cellular technologies
 - GPS, GPRS

Next Time

❖ We will know about

- Wide area networks
- circuit switching concepts
- Packet switching concepts
- Introduce ATMs

❖ Suggested Reading:

- Chapters 10 and 11 (Stallings)